



OFFICIAL PUBLICATION OF  
THE MINISTRY OF HEALTH,  
BRUNEI DARUSSALAM

# Brunei International Medical Journal

Volume 14

15 May 2018 (29 Syaaban 1439H )

## FUNCTIONAL OUTCOMES OF OPERATIVE FIXATION OF CLAVICLE FRACTURES AT A TERTIARY HOSPITAL IN MALAYSIA.

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### ABSTRACT

**Objective:** This study analysed the functional outcome of clavicle fractures in adults who were treated surgically and assessed the relationship between functional outcome in terms of shoulder function with fracture patterns, fracture location, fracture comminution, displacement, shortening and fracture union. **Methods:** Forty-three patients with clavicle fractures, which were treated surgically at a tertiary hospital six months earlier were recruited. Clavicle fractures were repaired with open reduction and reconstruction plates or locking plates were used in fixation and stabilisation of the fractures. They were evaluated both clinically and radiologically and the Constant Score Technique was used to evaluate shoulder function. **Results:** The relationship between open reduction and internal fixation of the clavicle with good functional outcome of the shoulder was statistically significant. There were no correlation of functional outcomes with fracture types (comminution), fracture displacement (21mm or more), shortening (15mm or more) and fracture union (asymptomatic non-union). There was a statistically significant relationship between distal third clavicle fractures with reduced shoulder function. **Conclusion:** In majority of clavicle fractures, open surgical reduction and internal fixation was associated with good outcomes of shoulder function except in those with distal third clavicle fractures.

**Keywords:** Clavicle, fractures, Fracture fixation, internal, Functional outcome

*Brunei Int Med J. 2018;14:55-60*

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## INTRODUCTION

Clavicle fractures are common in the adult population and it involves about 2% to 5% of all fractures.<sup>1</sup> Among children, the prevalence varies between 10% to 15% of all fracture cases.<sup>1</sup> By far, midshaft clavicle fractures make up a majority of clavicular injuries, with 65% cases in adults and 90% in the paediatric population.<sup>2-4</sup> Lateral third fractures made up

up 25% and medial third constitute the remaining 2% to 3% of all clavicle fractures. Displaced clavicle fractures have an increased risk of non-union.<sup>5,6</sup>

Most clavicle fractures are conventionally managed via non-surgical means but is associated with prolonged rehabilitation and pain as well as loss of productivity and disability.<sup>5,7</sup> Strength and range of movement have been reported to be reduced when compared to pre-injury or the contralateral shoulder and long term functional outcomes are not always satisfactory.

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Recent studies reported high prevalence of non-union or mal-union in displaced midshaft clavicle fractures, treated conservatively. The Canadian Orthopaedic Trauma Society reported significant improvement in functional outcomes with reduced malunion and non-union rates at one year follow up, in patients randomised to operative fixation of a displaced fracture of the clavicular shaft, compared to those randomised to non-operative management.<sup>3</sup> The authors advocated primary plate fixation of completely displaced midshaft clavicle fractures in active adult patients.

Although primary fixation of clavicle fractures are carried out at our centre, the functional outcomes of patients who had undergone operative repair at our centre have not been evaluated. Thus the objective of this study was to evaluate the functional outcomes of clavicle fractures in adults who were treated surgically and to assess the relationship between shoulder functional outcomes with fracture patterns, fracture location, fracture comminution, displacement, shortening and fracture union in our centre.

## **MATERIALS AND METHODS**

This was prospective observational cohort study conducted from May 2012 to April 2014 at Department of Orthopaedic and Trauma Surgery, Hospital Canselor Tuanku Mukhriz, Malaysia. Patients who had undergone primary open reduction and plate fixation of their clavicle fractures in the prior six months and who were attending follow up at our centre were recruited. The study received ethical approval from the ethical committee of the Hospital Canselor Tuanku Mukhriz and patient's or parental consent was obtained upon enrolment.

During follow up, patient's demographic data were collected from patient's medical records. Data on shoulder functional

outcomes post clavicle fixation were assessed using the Constant Score Technique.<sup>8</sup> Constant Score Technique is a scoring system with two subjective variables (Pain: 15 points, ADL: 20 points) and two objective variables (Range of motion: 40 points, Strength: 25 points) assessed, the summation of the scores, which are used to gauge the function of the shoulder based on European Society for Shoulder and Elbow Surgery (ESSES).<sup>8,9</sup> All functional assessments were performed by trained researchers, in order to maintain reliability of the data. Data on sites, types of fractures and operative procedures were retrieved from the patients' medical records.

## **Statistical analysis**

Nominal data were presented as percentage and continuous data were represented as median and inter quartile range (IQR). Data was analysed using SPSS version 19.0. Univariate analysis using Mann-Whitney test was used to explore predictor variables (types of plates used, location of fixation and days prior to surgical fixation) for functional outcomes based on Constant score. A p-value of < 0.05 was considered to be statistically significant.

## **RESULT**

A total of 43 patient with clavicle fractures who had undergone primary open reduction and plate fixation were recruited to the study. Almost half (46.5%) of the cohort were between 26 to 40 years old and 67.5% were male. Sixty-five percent of the group did not have any co-morbidities (Table I). Majority of the clavicle fractures were the result of motor vehicle accidents (MVA) (67.4%). The most common pattern of the fractures were oblique (46.5%) in nature and it involved a dominant hand in 55.8% of cases. The median displacement and shortening was 1.5 cm.

Reconstruction plates were used for the fixation in 30 (69.8%) cases and locking plate in the remaining 13 (30.2%) cases

Table I: Patient's demographic data and distribution of fractures characteristics.

Characteristics	Number (percentage) n (%)	Median (IQR)
<b>Gender</b>		
Male	29 (67.5)	
Female	14 (32.5)	
<b>Age group in years</b>		
15-25	6 (13.9)	
26-40	20 (46.5)	
40-55	13 (30.3)	
>55	4 (9.3)	
<b>Comorbidities</b>		
Diabetes Mellitus	4 (9.3)	
Hypertension	6 (13.9)	
Dyslipidemia	4 (9.3)	
Bronchial asthma	1 (2.3)	
Nil	28 (65.2)	
<b>Mode of injury</b>		
Assault	2 (4.7)	
Fall	12 (27.9)	
Motor Vehicle Accident (MVA)	29 (67.4)	
<b>Pattern of bone fracture</b>		
Oblique	20 (46.5)	
Transverse	10 (23.3)	
Comminuted	13 (30.2)	
<b>Displacement and shortening (cm)</b>		1.5 (1.0, 2.0)

\*values are expressed in median (IQR)

(Table II). Majority of the operative fixation involved middle part of clavicle (86%). The median operative treatment was 100 min with a median of 100ml blood loss recorded and the median waiting time to operation was 8 days. Only one patient required a revision surgery.

In term of surgical outcome, supraclavicular nerves were preserved in 25 (58.1%) cases (Table III). In the remaining 18 (41.9%) cases, the supraclavicular nerve was sacrificed due to adhesion to the fracture site or associated traumatic injury. None of

Table II: Distribution of surgical procedure.

Characteristics	Number (percentage) n (%)	Median (IQR)
<b>Fixation plates</b>		
Reconstruction plates	30 (69.8)	
Locking plates	13 (30.2)	
<b>Location of fixation</b>		
Middle	37 (86.0)	
Distal third	6 (14.0)	
<b>Treatment duration (min)</b>		100.0 (95.0,120.0)
<b>Days prior to surgical procedure (days)</b>		8.0 (4.0,14.0)
<b>Intraoperative blood loss (ml)</b>		100.0 (80.0,110.0)
<b>Revision surgery</b>		
Yes	1 (2.3)	
No	42 (97.7)	

these 18 patients complained of any adverse effect on the shoulder movement. Only two (4.7%) patients had post-operative infection. Fixation plates were removed in 9 (20.9%) patients. Satisfactory shoulder functional outcomes were observed in 30 (69.8%) Patients and in 74.4% of the cases, the patients were able to execute daily activities as pre-injury state. The median duration for the fracture union was 14 (IQR: 13,16) weeks. The median constant score in this study was 95 (IQR: 92,96).

There was no significant correlation observed between shortening ( $p=0.673$ ) and displacement ( $p=0.936$ ) on functional outcome based on Constant Score (Figure I). There was also no statistically significant difference in functional outcome based on Constant score between locking plates and reconstruction plates ( $p=0.106$ ; Figure II). The difference in functional outcome based on Constant score between middle third fixation and distal third fixation ( $p=0.007$ ) was statistically significant. Cases with middle third fixation had higher median score compared to the distal third fixation (Figure III). There was no significant correlation between days till opera-

Table III: Complication and distribution of surgical procedure outcome.

Characteristics	Number (percentage) n (%)	Median (IQR)
<b>Infection (superficial/deep)</b>		
Yes	2 (4.7)	
No	41 (95.3)	
<b>Supraclavicular Nerve</b>		
Preserved	25 (58.1)	
Sacrificed	18 (41.9)	
<b>Constant score</b>		95.00 (92.0,96.0)
<b>Patient satisfaction</b>		
Not satisfied	1 (2.3)	
Partially satisfied	12 (27.9)	
Satisfied	30 (69.8)	
<b>Return to Previous Activity</b>		
Less Strenuous	11 (25.8)	
Pre-injury	32 (74.4)	
<b>Removal of Implant</b>		
Yes	9 (20.9)	
No	34 (79.1)	
<b>Duration of union (weeks)</b>		14.0 (13.0, 16.0)

\*For 40 cases only. The 3 other cases were asymptomatic non-union

tion with fracture outcome (p=0.263).

**DISCUSSION**

Clavicle fractures consist of 45% of shoulder girdle injuries, in which 80% are middle third fracture.<sup>1,5</sup> Although clavicle fractures usually unite uneventfully with intervention, difficult early and late complications can still occur. Indication for a primary open reduction and internal fixation are clavicle fractures which involved significant displacement of the fracture site, severely comminuted fracture and tenting of the skin.

Based on the demographic data, the commonest mode of injury resulting in clavicular fractures was following motor vehicle injury, thus it was not surprising that majority

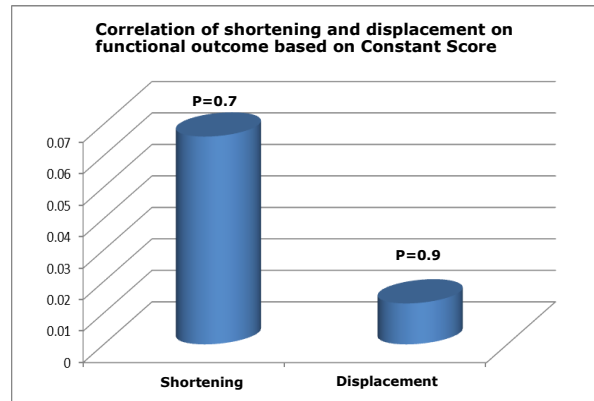


Figure 1: Correlation of shortening and displacement on functional outcome based on Constant Score. (Spearman correlation,  $r^D$ : Spearman rho correlation coefficient. \*Significant if p-value < 0.05

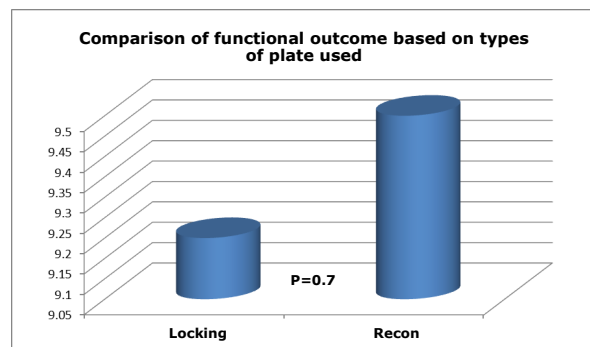


Figure 2: Comparison of functional outcome based on types of plate used. Mann-Whitney U Test. Significant if p-value < 0.05

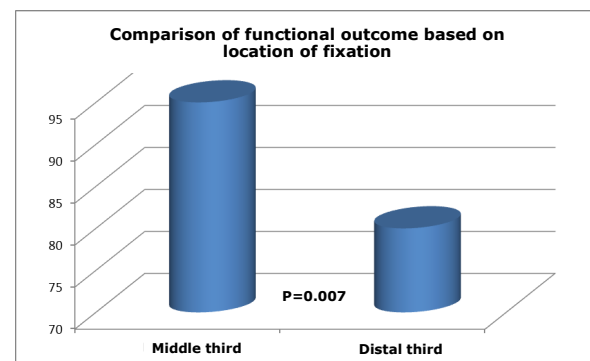


Figure 3: Comparison of functional outcome based on locations of fixation. Mann-Whitney U Test. Significant if p-value < 0.05

of the patients were young healthy adult males with no co-morbidities (Table 1). In present study, the results demonstrate a significant relationship between surgery of clavicle fractures and good functional outcome of the shoulder. The average constant score observed in the study ranged between 75 to 98



with a mean score of 95.0. Of the 43 patients, all but three patients exhibited clinical and radiological union of the fracture sustained. Of the three aforementioned patients, despite not achieving radiological union, their functional outcome was not disturbed as evidenced by a high Constant Score.

Our findings of poorer functional outcome with surgical fixation of the distal third clavicle fractures, also mirrored the findings of several other authors who reported similar poor functional outcomes in distal third fractures despite being treated conservatively or surgically. Current understanding dictates that unstable distal third fractures should be treated via surgical means.<sup>10</sup> A plethora of surgical options exist for fixing distal clavicles, such as coracoclavicular screw fixation, transarticular K-wire fixation, tension band fixation and plate fixation all being suggested. No consensus exists determining which form of fixation is better than the other or whether fixation of distal clavicles is superior to non-surgery treatments.

In our study, both reconstruction plates and locking plates were utilised to treat clavicle fractures. A majority of the patients opted for reconstruction plates due to financial constraints and a majority of the distal third fractures were fixed using locking plates with lateral extensions. However, statistical analysis does not indicate any significant superiority of one plate over the other in terms of a higher functional score.

Mohd *et al* noted a statistically significant difference in functional outcome of shoulders treated conservatively in terms of their fracture pattern, shortening and displacement.<sup>11</sup> A displacement of 21mm or more displayed a significant reduction in shoulder functions. Another study reported that a fracture displacement of 20mm or more was associated with mediocre outcomes.<sup>12</sup> Clavicle fractures with a shortening

(on AP View) of 14mm revealed no reduction in the shoulder functions, but significantly reduced shoulder functions were caused by shortening of 15mm or more. This data corroborates an earlier study by Goss and Constant *et al* which concluded that a shortening of more than 15mm was associated with shoulder discomfort and dysfunction.<sup>12,13</sup> Another research concluded that a shortening of more than 14mm was statistically associated with unsatisfactory results.<sup>14</sup> With a shortening of 15mm, biomechanical assessment showed a reduction in the muscular strength for adduction, extension and internal rotation of the humerus as well as a reduced peak abduction in the injured shoulder.<sup>11</sup>

In the present study, fracture configuration, shortening and displacement of the fracture did not lead to a statistically significant reduction in functional outcome. Lack of cortical apposition and fracture comminution leads to an impaired shoulder function as they increase the likelihood of developing non-union.<sup>15</sup> However, in the clavicles that were treated surgically, direct cortical contact afforded by fixation negates the effects of angulation, shortening and displacement seen in fractures that are treated conservatively.

Indeed, the rates of non-union in clavicle injury cases treated with surgical intervention are lower than that of cases treated conservatively. In the present study, 40 of the 43 patients achieved clinical and radiological union resulting in a significant relationship with a good Constant score. There was no significant relationship between union and asymptomatic union in terms of Constant score in our study, indicating that despite radiological non-union, the patients still maintained good shoulder functions.

A recent Cochrane review reported that despite surgical intervention yielding good functional outcome, there is no difference in terms of functional outcome compared

to the conservative treatment.<sup>14</sup> However, the review did note a significant difference in terms of rates of non-union, with a higher union rate seen in clavicles treated surgically. The Cochrane review only included fractures of the middle clavicle and did not include distal third fractures. Treatment of the distal clavicle remains contentious with no consensus regarding timing of surgery nor optimal fixation method.

### Limitation of the study

The limitation of this study is the small sample size but despite this, we were able to demonstrate a significant difference in functional outcomes between distal third clavicle fractures and middle third clavicle fractures, with the latter achieving better outcomes. Another limitation is the retrospective nature of the patients' selection for the study in that the patients have already undergone surgical fixation 6 months ago. This may introduce bias in fixation plates selection, type of repair etc. Future studies should focus on comparison between surgical and conservative intervention of distal third fractures and the suitable surgical modality for their treatment.

### CONCLUSION

The treatment of clavicle fractures continues to confound. Our study shows that there is a significant relationship between surgical fixation of clavicle fractures and good functional outcome. Fracture configuration, shortening, and displacement do not play a significant role in adversely affecting outcome with shoulders that are treated surgically.

### ACKNOWLEDGEMENTS

The authors would like to thank Dr Abdul Muhaimin Ali for his indirect involvement and technical help.

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